

# Quantifying Meteorite Impact Craters

By Walt Gray



**Targeted Age:** High School/Middle School

**Activity Structure:** Group Project (2–3 students)

**Indiana Standards and Objectives:** ES 2.3, ES 5.3

## Materials

playground sand	metric ruler
42cm x 42cm tray	meter stick
3 small spheres of various size	
metal density cube set*	

\* (available from most scientific supply companies)



## Introduction

This lesson is designed to examine how the volume, mass, and speed of meteorite impact will affect the dimensions of the resulting crater produced on the earth's surface.

## Background Information

Meteoroids are pieces of rock that once were part of another celestial body. These pieces of rock can be of microscopic size to several meters across. When the rock enters the earth's atmosphere, it is referred to as a meteor or "shooting star." If the rock strikes the surface of the planet, we change the terminology again and refer to the object as a "meteorite."

Most meteors burn up in the atmosphere, and those that impact our planet are usually extremely small. Few meteorites are ever found and therefore are extremely rare. Only thirteen confirmed meteorite falls or finds have been

documented in the state of Indiana. For more information related to Indiana meteorites, refer to Poster 11 published by the Indiana Geological Survey.

Only a small number of meteorites that strike the earth's surface actually create a significant impact crater. These impacts typically result in circular-shaped craters. Impacts at extremely low angles create elongated craters.

### **Experiment One: Meteorite Volume (Size)**

In this segment of the investigation we will examine the effects of meteorite volume and the resulting crater that is produced.

1. Fill the tray with sand so that the layer of sand is approximately 0.5 cm thick.
2. Use a metric ruler to create a smooth, even layer of surface across the entire tray.
3. Using the meter stick to estimate the height, drop the largest sphere from a height of 150 cm.
4. Observe and record the shape of the crater produced by the impact.
5. Measure and record the diameter of the crater. The peak of the crater rim should be used as reference points.
6. Carefully remove the sphere and measure the crater depth. Record the crater depth on the data table.
7. Make the surface of the sand smooth again using the metric ruler.
8. Steps 2 through 7 should be repeated using the same sphere for trial two and three.
9. Next, repeat the experiment using steps 2 through 8 for each of the remaining spheres.

### **Experiment Two: Meteorite Velocity**

Dropping the same sphere from varying heights will allow us to examine the effects of meteorite speed at the point of impact on crater dimensions and shape. Depending on the various sizes of your spheres, the larger sphere may be easier to use in this segment.

1. Use a metric ruler to create a smooth, even layer of surface across the entire tray.
2. Using the meter stick to estimate the height, drop the largest sphere from a height of 150 cm.
3. Observe and record the shape of the crater produced by the impact.
4. Measure and record the diameter of crater. The peak of crater rim should be used as reference points.
5. Carefully remove the sphere and measure the crater depth. Record the depth.
6. Make the surface of the sand smooth again using the metric ruler.
7. Steps 2 through 6 should be repeated using the sphere for trial two and three.
8. Next, repeat the experiment, dropping the same sphere from 100 cm and then 50 cm.

### **Experiment Three: Meteorite Mass**

Density cube sets are designed so that each cube is the same volume (size). We will examine the effects that a meteorite mass has on crater dimensions and shape.

1. Calculate and record the mass of the steel, aluminum, and acrylic density cubes.
2. Use a metric ruler to create a smooth, even layer of surface across the entire tray.
3. Using the meter stick to estimate the height, drop one of the cubes from a height of 50 cm.
4. Observe and record the shape of the crater produced by the impact.
5. Measure and record the diameter of the crater. The peak of the crater rim should be used as reference points.
6. Carefully remove the density cube and measure the crater depth. Record the crater depth on the data table.
7. Make the surface of the sand smooth again using the metric ruler.
8. Steps 2 through 6 should be repeated using the same cube for trial two and three.
9. Next you should repeat the experiment using steps 2 through 7 for each of the remaining density cubes.



## **Data Reporting Options**

As an instructor you can consider multiple options related to how student data are reported. Other than the traditional practice of submitting lab reports, the teacher should consider allowing students to report the data to the rest of the class. This would provide an excellent opportunity to create more data points and the ability to graph those data points using Microsoft Excel spreadsheets. You might also wish to compare and discuss the results for each of your classes. This is applicable only if each group used the same materials during the experiments. Note: Marbles and superballs are two affordable options so that students can compare answers to those of the classmates.

## **Data Analysis Questions**

1. How did the volume of the sphere (meteorite) affect the diameter and depth of the crater?
2. Dropping a sphere from different heights results in different speeds at the time of impact. Did you observe any affects on the crater diameter and depth by dropping a sphere from different heights? Explain your answer.
3. How did meteorite mass affect the dimensions of the crater produced?
4. Quantify the effect that each meteorite variable (volume, mass, speed) had on the resulting crater dimensions?

## **Extension or Enrichment Ideas**

Research the classification schemes used in the study of meteorites. What are the major characteristics of each type of meteorite?

What is the difference between a meteorite “fall” and a “find”?

Research the difference between simple and complex craters.

Explain how scientists study the frequency of meteorite impacts.

Explain how large meteorite impacts could affect earth’s climate.